European Monitoring Centre
for Drugs and Drug Addiction

RAPID COMMUNICATION

Recent changes in Europe's MDMA/ecstasy market

Results from an EMCDDA trendspotter study

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Legal notice

Luxembourg: Publications Office of the European Union, 2016

ISBN: 978-92-9168-911-8
doi:10.2810/817237

Recommended citation: European Monitoring Centre for Drugs and Drug Addiction (2016), *Recent changes in Europe's MDMA/ecstasy market,* EMCDDA Rapid Communication, Publications Office of the European Union, Luxembourg.

Printed in Spain

PRINTED ON ELEMENTAL CHLORINE-FREE BLEACHED PAPER (ECF)

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Study rationale and methods

In recent years signals from both formal and informal monitoring sources based in a number of countries have been flagging critical new developments within Europe's MDMA/ecstasy market. These include signs of increased MDMA production and availability, the opening of new online markets, reports of increased use, the issuing of alerts on both high-dose MDMA tablets and adulterated tablets, and evidence of low but potentially rising numbers of MDMA-related hospital admissions, and even deaths in some countries.

In order to investigate these changes and developments in the supply and demand of one of Europe's more established illicit drugs, a targeted 'trendspotter' study was initiated by the European Monitoring Centre for Drugs and Drug Addiction (EMCDDA) and carried out between August and October 2015. The primary aim of the study was to increase understanding of recent changes in the MDMA market in Europe. More specifically, the study set out to explore: levels and patterns of MDMA use; the MDMA market including production, supply and product availability; MDMA-related harms and deaths; and implications for law enforcement, health and social responses.

The study commenced with a phase of data collection and a literature review undertaken by a team drawn together from different sectors within the EMCDDA, and culminated in an expert meeting in Lisbon on 22–23 October 2015. Fourteen experts attended the meeting, sharing their experiences and contributing to an in-depth analysis of the topic, providing insights from drug research and monitoring, wastewater analysis, law enforcement and health perspectives.

The trendspotter study methodology incorporates a range of different investigative approaches and data collection from multiple sources. This study included two expert web surveys, a review of the international literature and available monitoring data, 15 expert presentations and findings from three facilitated working groups. Analysis was based on triangulation of these information sources, with a view to providing as complete and verified a picture as possible. The combination of routine and survey data with key informant reports and law enforcement intelligence provided a rich and in-depth view of a rapidly changing phenomenon. This report summarises the study findings and conclusions. Where results are literature-based, references are cited, otherwise findings are based on EMCDDA monitoring and the qualitative sources described above.

A short history of MDMA/ecstasy

The German pharmaceutical company Merck first filed a patent for MDMA in 1912 but it was only in 1960 that its synthesis was first reported ([1]). The substance was initially intended to be used as an anti-clotting agent and underwent animal testing. It was not until the 1970s, however, that the psycho-pharmacologist Alexander Shulgin began exploring the use of the drug in humans and the substance was taken up in certain American psychotherapy circles. The 1980s saw the beginning of the open sale and recreational use of MDMA, first known as 'empathy' and shortly after as 'ecstasy'. Its rise was closely associated with the popular house/rave and techno music scenes that started in Chicago and quickly spread through Europe, and with the so-called Second Summer of Love in the United Kingdom in 1988. In terms of control, MDMA was placed on Schedule I of the United Nations Convention on Psychotropic Substances, 1971 in 1986.

In part as a response to a number of high-profile MDMA-related deaths, the 1990s saw an increase in the development of harm reduction initiatives including safer nightlife programmes and pill testing projects. While in the early 2000s there was a renewed popularity and mainstreaming of the electronic dance music scene, the end of the decade was characterised by a shortage of quality MDMA products on the market due to the limited availability of precursors. During this period many ecstasy tablets on the illicit market contained little or no MDMA, with its replacement by piperazines, cathinones and other new psychoactive substances (NPS). From 2010 onward the tide appeared to turn again, and the new developments in the MDMA market in 2011–15 are the focus of the rest of this report.

A range of MDMA products

The 'ecstasy-type' drugs MDMA, MDA and MDEA belong to the group of synthetic compounds collectively known as amphetamine-type stimulants. MDMA (3,4-methylenedioxyamphetamine) is a member of the substituted phenethylamine class of drugs. MDMA was the original chemical in pills sold as ecstasy, along with adulterants such as caffeine. In the last decade, however, many other substances — both active drugs(s) and adulterants — have been identified in so-called ecstasy pills.

([1]) Narconon Drug Rehabilitation and Education (2015), 'Drug information: history of ecstasy (MDMA)' (www.narconon.org/drug-information/ecstasy-history.html).

MDMA freebase is a thick oil that is unstable and highly caustic and therefore not suitable for consumption. The synthesis of MDMA involves the conversion of the oil into a crystallised salt, the most common being a hydrochloride, although phosphate salt is also found.

The MDMA products that are consumed include crystal MDMA, which is also available as a powder, and MDMA in tablet form. Pure crystal MDMA is translucent white with a coarse structure and the crystals may be pulverised into powder with a 'crystalline' shimmer. Crystals and powders may be sold loose (in bags or papers/parachutes) or in capsules. Tablets are usually pressed from powders, but occasionally may contain discernible crystals. It is unclear whether this is linked to poor grinding methods or is a marketing technique.

MDMA markets — production and supply

Global market context

At the global level the precursor trade, production and trafficking of MDMA has in recent decades been operated by organised crime groups (OCGs) based in north-west Europe, and MDMA precursors such as safrole (3,4methylenedioxyallybenzene, a liquid extracted from sassafras plants) and later PMK (piperonyl methyl ketone, itself derived from safrole) were imported from Asia. Until recently, facilities in the Netherlands and Belgium have represented the only major MDMA production hub, with products trafficked by crime groups primarily to European and North American markets. Although production in the Netherlands and Belgium is on the increase, with clandestine laboratories becoming larger and more professional, north-west Europe is no longer the sole source of MDMA on the global market (UNODC, 2015). In recent years production has reportedly been taking place in other countries, including both Canada and China.

North America is seeing increases in MDMA trafficking and use, with production sites found both in the United States and Canada. MDMA is also gaining popularity in South America, with Brazil already having a major market (UNODC, 2015), and with recent law enforcement reports suggesting that MDMA has been exchanged for cocaine in Brazil by European OCGs. In addition, east and south-east Asia and Oceania now also represent major ecstasy markets (UNODC, 2015).

Reports suggest that high-strength European tablets are favoured by consumers in Asia. According to one hypothesis, the increased availability of high-purity MDMA tablets on the global market reflects the growing importance of the Asian market in global MDMA trade. In North America these stronger tablets are often referred to as 'Euros'.

MDMA precursor trends

The four main MDMA precursors are safrole (3,4-methylenedioxyallybenzene ([2])), isosafrole (3,4methylenedioxypropenylbenzene ([3])), piperonal (3,4methylenedioxybenzaldehyde ([4])) and PMK (piperonyl methyl ketone, also known as 3,4methylenedioxyphenyl-2-propanone or 3,4MDP2P ([5])). Trade in these four substances is internationally controlled. While licit trade in PMK is virtually non-existent, licit trade in (iso)safrole/safrole-rich oils amounts to approximately 4 500 litres per annum, and legitimate trade of piperonal reached almost 2 400 tonnes in 2013 (INCB, 2014). Most illicit MDMA is now produced with PMK as the starting material. PMK has typically been produced in China and trafficked into Europe via the ports of Rotterdam and Antwerp for illicit MDMA production (UNODC, 2012).

The shortage of safrole in 2008 and the following years was associated with several new substances appearing on the MDMA precursor market. In China a new MDMA pre-precursor called PMK-glycidate became available around 2010, revitalising MDMA production in recent years. PMK-glycidate is not derived from safrole and is therefore not vulnerable to natural shortages. To date, the trade in PMK-glycidate remains legal, which makes it difficult for law enforcement to control. With PMK-glycidate, new ports in countries that are not traditionally associated with MDMA production are reported to be increasingly used as entry points, with seizures reported in Romania, Slovenia and Spain.

Seizures of PMK-glycidate amounting to 2 077 kg were reported in 2013, and in June 2014 one tonne of PMK-glycidate (enough to make seven million ecstasy tablets, according to the police) was found in Barcelona's port on a shipment from Shanghai bound for Maastricht in Holland (Daly, 2015). In addition, reports from law enforcement indicate 4metoxyBMK is sometimes sold to unsuspecting MDMA producers, who then produce PMMA instead of MDMA.

([2]) IUPAC name: 5-(2-propenyl)-1,3-benzodioxole.
([3]) IUPAC name: 5-(Prop-1-enyl)benzo[d][1,3]dioxole.
([4]) IUPAC name: 1,3-Benzodioxole-5-carbaldehyde.
([5]) IUPAC name: 3,4-methylenedioxyphenylpropan-2-one.

Production and trafficking

Production of MDMA takes place mainly in the Netherlands and Belgium, and the predominant synthesis technique used is reductive deamination. Chemicals essential to the process, such as acetone or methylamine, have reportedly been bought from countries that are not traditionally associated with MDMA production, for example Germany, Poland or Romania.

There are currently a small number of OCGs involved, and it is common for production facilities to specialise in one production step, such as pre-precursor conversion, MDMA oil synthesis, crystallisation or tableting. Although all these steps are routinely performed in the Netherlands and Belgium, tableting also occurs in other countries, such as the Czech Republic, Germany and Spain. This compartmentalisation of the production process appears to be aimed at reducing vulnerability to law enforcement threats. Other new developments include the use of mobile production sites on trucks, which helps to extend the geographical span of production. There is also evidence of 'production to order', with MDMA laboratories closing down once a production run is completed. The lack of excess precursors seized during raids on illicit production sites suggests that the correct volumes of precursors are provided 'on demand' for each production batch.

A number of new developments appear to be playing a role in the recent increased production of high-quality MDMA. These include reports of more sophisticated and industrial-scale MDMA labs and increasing production expertise (especially in the Netherlands and Belgium). Production volumes have also been rising, and in some MDMA production sites custom-built reaction vessels have been found with a capacity of 750 litres. Dutch labs appear to be producing higher purity products than elsewhere, which may be linked to the skills of the illicit chemists (cooks). Producers also have easy access to cheap tableting machinery from China, and to pre-mixed coloured excipients and tablet stamps. The issue of low-level but increasing local production of MDMA tablets has also been identified. There are reports of 'hobby chemists' from a number of countries, and also individuals who purchase MDMA crystals from internet markets and produce tablets themselves.

Wastewater analysis can provide useful indicators of signs of MDMA production; for example, some cities in the Netherlands exhibited abnormally high values for MDMA, which was due to the release of MDMA directly into the sewer system, presumably to avoid law enforcement activities (EMCDDA, 2015b). In addition, an increase in the dumping of dangerous waste products from MDMA production processes has been reported by law enforcement agencies and is considered an environmental concern in the Netherlands and Belgium.

With regard to trafficking, the vast majority of European production is destined for internal markets, with Germany and the United Kingdom being the most common destinations. There is no evidence of MDMA being imported into the European Union (EU). Assessing recent trends in MDMA seizures is difficult due to the absence of data from some countries that are likely to make important contributions to this total. The Netherlands reported seizing 2.4 million MDMA tablets in 2012, and if a similar figure may be assumed for 2014 it can be estimated that around 5.5 million MDMA tablets were seized in the EU in that year. This would be more than double the number seized in 2009.

Organised crime groups also produce MDMA for intercontinental export (to Australia, Brazil and the United States in particular). It is reported that some MDMA is being exported through the Balkan Route, and Turkey has recently started seizing large amounts of MDMA (3.6 million tablets in 2014). It remains unclear how much MDMA eventually leaves the country, and to which countries it is being trafficked. Export may be a particularly lucrative option, with prices often much higher in non-EU countries. MDMA is trafficked by road, rail, sea and air. Postal packages are also becoming popular as internet sales are increasing. A new development is the trade in MDMA oil, for subsequent conversion, which is trafficked between criminal organisations within the Netherlands, within the EU (e.g. to Spain), and for export (e.g. to Australia or Brazil). The oil can be re-crystallised on arrival at its destination. Seizures of MDMA alongside other products suggest that it is tied in to broader multi-commodity trafficking processes.

MDMA trade in online drug markets

MDMA is one of the most popular drugs bought through online and anonymised darknet markets. These markets exist on the deep web, an area of the internet that has been intentionally hidden and is inaccessible through standard web browsers. Based on an analysis of 16 darknet drug marketplaces between 2013–15, Soska and Christin estimated that MDMA accounted for about 25 % of market demand (Soska and Christin, 2015). Similarly, Ciancaglini et al. of TrendLabs conclude in their 2015 report *Below the surface: Exploring the deep web* that MDMA is the third most commonly sold drug on darknet sites (after cannabis and pharmaceuticals). The Global Drug Survey (Winstock, 2015), an online survey that specifically targets drug users, found that MDMA was

reported to be the most commonly purchased drug through darknet markets among their sample.

Studies suggest that a large proportion of darknet purchases of MDMA may be for resale. MDMA annual revenue on the Silk Road marketplace has been estimated at just under USD 20 million, with 45 % generated by high-price product listings — suggesting transactions at the middle to wholesale level (Aldridge and Decary-Hetu, 2014). In 40 % of the most expensive listings of MDMA, the average listing price (mean USD 2 072) and the quantities (mean 26 g) were consistent with purchase for resale (Aldridge and Decary-Hetu, 2014).

For MDMA, and for other drugs sourced via darknet markets, studies have highlighted user reports of higher quality products being available than from alternative supply sources (Barratt et al., 2014; Winstock, 2015; Van Hout and Bingham, 2013a). Purchasing from the darknet also enables customers to buy from vendors located in countries perceived to be associated with the production of high-potency drugs (e.g. the Netherlands) (Van Hout and Bingham, 2013b).

There have also been reports of the sale of MDMA over surface websites such as the now-defunct Shiny Flakes and via social networking applications.

Recent increases in purity

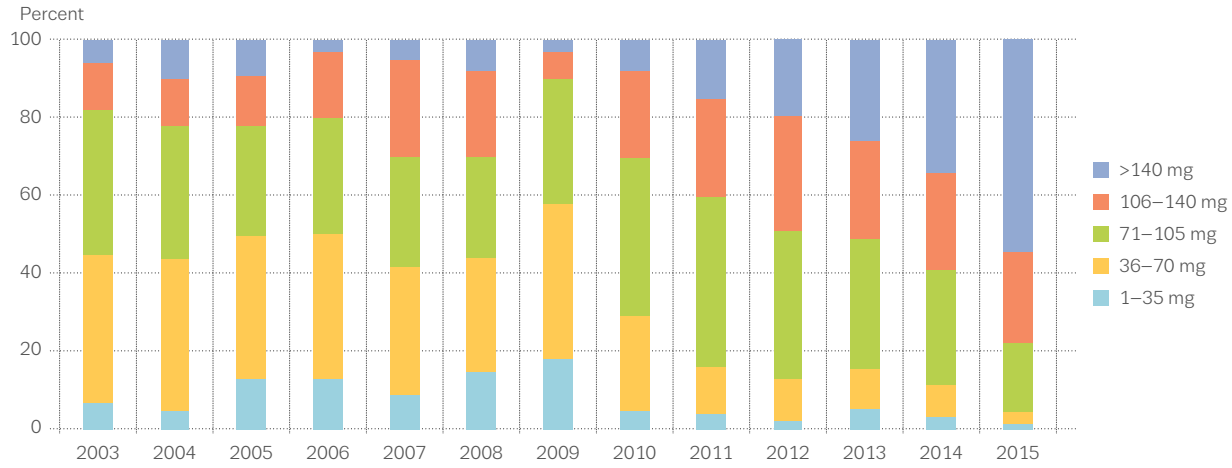
Prior to 2005 most tablets tested in Europe contained MDMA or another MDMA-like substance (MDEA, MDA) as the only psychoactive ingredient. In France, for example, the SINTES monitoring system showed that 82 % of more than 7 000 tablets collected and analysed between 1999 and 2004 contained MDMA. Pills with a dose higher than 150 mg were very rare (Giraudon and Bello, 2003, 2007). Changes occurring in the late 2000s saw the virtual disappearance of MDMA as the active ingredient in ecstasy tablets, accompanied by increased tablet adulteration/substitution with other psychoactive substances. The downward trend was most pronounced in 2009 when seizure data suggest that the majority of MDMA tablets on European markets contained no MDMA at all.

From 2010/11 MDMA products have gradually re-emerged on the market, often at higher levels of purity. The first powders that appeared after the MDMA shortage were reportedly very pure; however, their quality declined over time. The subsequent market development saw the growing popularity of MDMA crystals, which were less easy to adulterate. Some recently produced batches of MDMA tablets contained discernible crystals, apparently as a strategy to increase user trust.

In the 1990s and 2000s the average MDMA content of tablets was somewhere between 50–80 mg, as reported by drug checking services and forensic institutes (Wood et al., 2011). At present the averages are closer to 125 mg MDMA per tablet, while there are also 'super pills' found on the market in some countries with a reported range of 270–340 mg. There are reports of large variations in the dosage in similar looking tablets. Data from the Drug Information and Monitoring System (DIMS) in the

FIGURE 1

DIMS reports of MDMA tablet content levels in the Netherlands, 2003–15



Source: DIMS, 2015.

Netherlands, which tests around 10 000 drug samples annually, confirm both the re-emergence of MDMA in the country, starting in 2011–12 then increasing rapidly from 2013, and the trend of increasing purity of MDMA pills (Figure 1). Figure 1 shows that over half (53 %) of all ecstasy tablets tested in 2015 contained over 140 mg of MDMA compared to just 3 % in 2009.

In addition to increases in MDMA content, there has also been an increase in the size of some of the tablets available. In France the SINTES monitoring system reported that the weight of MDMA pills increased on average from 204 mg in 2009 to 325 mg in 2014.

In March 2014 the EMCDDA and Europol jointly released an early warning notification on MDMA tablets with dangerously high levels of MDMA found in the Netherlands, Belgium, Switzerland and the United Kingdom. On 2 October 2015 the Dutch Trimbos Institute issued an alert warning about yellowish-white tablets with the Amsterdam Dance Event (ADE) logo, in circulation in the Netherlands, containing 300 mg per tablet (www.mixmag.net/read/dutch-health-officials-warn-of-ade-ecstasy-pills-news).

Adulteration/substitution

Unlike powders or crystals, which in theory can be absolutely pure, tablets cannot contain solely MDMA, as it is impossible to press the salt into pills without the addition of binding agents. Typically, MDMA does not exceed 30–40 % of the material constituting a tablet, the bulk of it being formed by binders/fillers. A filler substance with no pharmacological properties is not considered an adulterant. Information provided by the Spanish drug checking services Energy Control shows that caffeine was an adulterant in both tablets and crystal samples tested; however, tablets also contained mCCP and TFMPP (both piperazines), while crystals were more commonly adulterated with procaine and methamphetamine.

The euphoric and entactogenic effects of MDMA have proven very difficult to replicate in any other substance. Numerous NPS have been used as adulterants/substitutes in ecstasy tablets, but most seem to produce less desirable effects. However, mephedrone emerged between 2007 and 2009, and became popular in several EU countries during the times of MDMA shortage (Brunt et al., 2011). Recently, 4fluoroamphetamine (4FA), has been gaining popularity in the Netherlands, where it is known as 'ecstasy light' because of its effects, reportedly ranging between those of amphetamine and MDMA (Linsen et al., 2015). Reports from the Belgian Early Warning System identified a number of MDMA tablets containing a range of different NPS seized at the Tomorrowland festival, including, for example, alpha PVP. In Portugal the CHECK!N/APDES drug testing service notes that the closure of shops selling NPS in 2013 appeared to coincide with the re-emergence of MDMA pills on the country's drug market.

Other substances reported to be found in tablets sold as MDMA/ecstasy included 2CB, ketamine, piperazines (TMFPP, mCPP, BZP), amphetamine, PMA and PMMA. In 2009 piperazines were present in most 'ecstasy' tablets sold in Europe, which probably contributed to the observed decrease in popularity of the drug. Another adulterant is PMMA, which has proven particularly hazardous.

In recent years, all EMCDDA alerts of adulterants/substitutes present in MDMA/ecstasy tablets were related to PMMA, including 11 alerts of PMMA-associated deaths between 2011 and 2015. Recently, an alert of tablets containing PMMA was released in June 2015 by saferparty.ch in Bern, Switzerland (relating to 81 mg PMMA, a pink round tablet with a crown logo). In July 2015 three deaths associated with tablets containing PMMA were reported in Poland (orange triangular tablets with a Superman logo).

Marketing of MDMA

A key feature of the contemporary MDMA market has been the creative and sometimes aggressive marketing of products, most recently particular MDMA tablet brands. This has included the use of logos (e.g. Superman, UPS), a variety of shapes, bright and fluorescent colours, and larger size/weight tablets. MDMA tablets are also produced specifically for individual events, typically music festivals such as Tomorrowland or Amsterdam Dance Event (see Figure 2). The Dutch police report a sharp increase in the number of new tablet designs, from 50 new designs identified in 2012 to a peak of 174 in 2014. This product specialisation and differentiation has had its own micro trends. Often a new brand of high-quality MDMA tablets comes out on the market associated with a particular Dutch producer. These gain a reputation among customers but are rapidly copied by other producers and lower potency versions of the same product are released onto the market.

FIGURE 2
MDMA tablets designed for specific events

Tablet made for the Tomorrowland electronic music festival (Belgium). This tablet was analysed in Switzerland in 2015 and found to contain a dangerously high level of MDMA (more than 200 mg).

Photo © Pharmaceutical Control Laboratory, Office of the Cantonal Pharmacist, Bern, Switzerland

Tablet made for the Amsterdam Dance Event (ADE) electronic music festival, also found to contain dangerously high levels of MDMA (2015).

Photo © DIMS, Trimbos Institute, the Netherlands

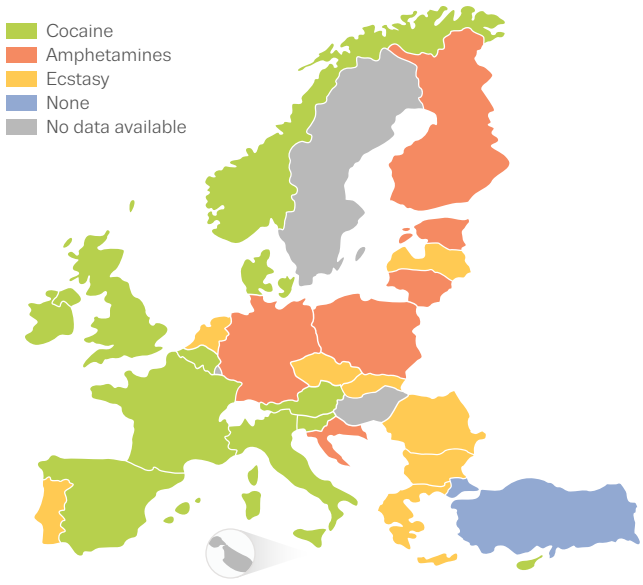
MDMA use and cultural context

Levels and patterns of MDMA use

While tablets known as ecstasy were for decades the main form of marketed MDMA, there was a discernible shift around ten years ago as users lost trust in tablets and began to switch to using MDMA powders and crystals. Since 2010 tablets have had a better reputation for quality, and on the contemporary European market MDMA crystal/powder and tablets can be parallel and sometimes competing products. Among users, the preference for particular product types varies by country and appears to be associated with availability and driven largely by a search for quality/potency. Crystal MDMA may be regarded by users as more difficult to adulterate and therefore likely to be purer than powders or tablets (this is not always true in reality). Results from the recent online Global Drugs Survey support this mixed pattern of use of both MDMA pills and powders, and differing product preferences by country (Winstock, 2015). Similarly, patterns and levels of use are also interlinked with local and national stimulant markets and the availability and quality of alternative products, for example with methamphetamine in the Czech Republic and cocaine in Spain.

Much information on MDMA use comes from general population and targeted surveys, and most European surveys have historically collected data on ecstasy rather than MDMA use. The most recent EU-level estimate suggests that around 1.8 million young adults (aged 15–34) used MDMA/ecstasy in the last year (1.4 % of this age group), with national estimates ranging from 0.3 % to 5.6 %. Countries with the highest prevalence of MDMA use in Europe include the Netherlands, the Czech Republic, the United Kingdom, Bulgaria and France. MDMA is the predominant stimulant used (ahead of cocaine and amphetamines) in a number of countries in this young adult group, although the prevalence may be low (see Figure 3). Wastewater data from the SCORE group found the highest MDMA concentrations in cities in the Netherlands and Belgium and the lowest concentrations in southern European cities (EMCDDA, 2015b).

FIGURE 3
Predominant stimulant used by country, according to last year prevalence of use for young adults (aged 15–34)



Source: EMCDDA Statistical Bulletin, available at http://www.emcdda.europa.eu/data/stats2015

MDMA is often taken alongside other substances, in particular alcohol. This study identified reports of small-scale and sometimes niche polydrug combinations including: MDMA and amphetamine; MDMA, amphetamine and ketamine (triphasic); and MDMA and LSD (known as 'candyflipping').

Trends in MDMA use tend to mirror the availability and supply of the drug, with increases in Europe during the 1990s and decreasing prevalence levels in the early 2000s, especially among those countries with higher levels of use. Among the 12 countries that have produced new surveys since 2013, results suggest a recent overall increase in Europe, with three-quarters (nine) reporting higher estimates than in the previous comparable survey.

It seems likely that there is something of a ripple effect, with certain trendsetter countries such as the Netherlands and the United Kingdom reporting increases in prevalence that have possibly already plateaued, with another set of countries following the same trend a year or two later. At the other end of the scale, Latvia and Lithuania, for example, have not reported any increase in MDMA use nor in the availability of high-purity tablets. Where city-level information is available this appears to confirm an overall rising trend. A German city monitor based in Frankfurt (MoSyD) identified a significant increase in MDMA prevalence in a school survey of 15- to 18-year-old students, with the prevalence rate doubling from 2 % to 4 % between 2013 and 2014 (Werse and Kamphausen, 2015). Similarly, a local monitor in Bergen, Norway (Fore Var) reported strong increases in MDMA use and availability between spring 2014 and autumn 2015 (Flesland and Knoff, 2015).

Wastewater data also provide some insight on trends, with a sub-set of cities involved in multiple wastewater monitoring campaigns between 2011–15. Strong increases in MDMA loads were found in cities in the Netherlands.

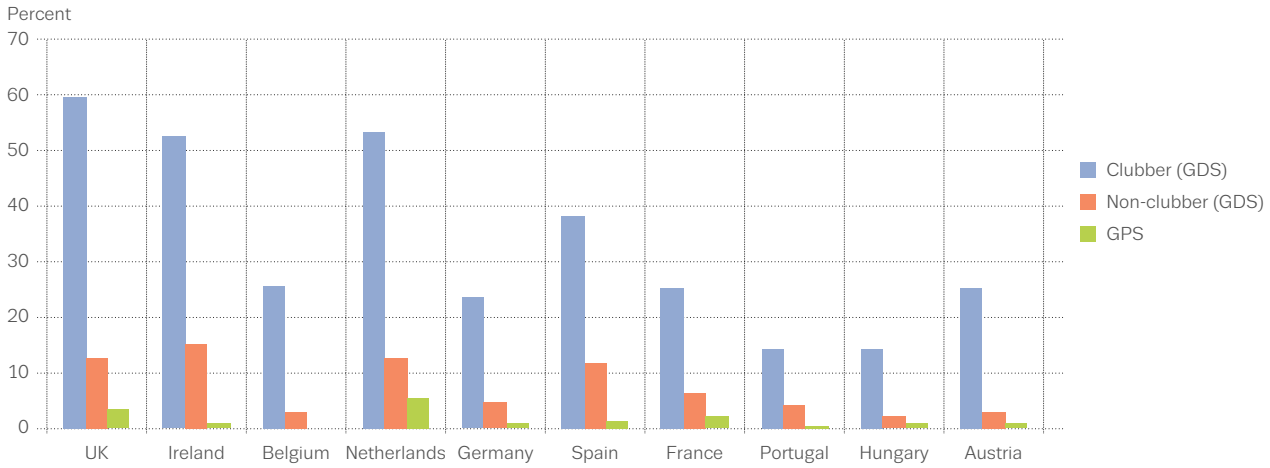
MDMA use by clubbers

Typically, surveys of young people who regularly attend nightlife events indicate higher levels of drug use compared with the general population. This is particularly the case for MDMA, which has historically been closely linked with nightlife settings and especially electronic dance music. The Global Drug Survey reported levels of last year prevalence of MDMA use nearly 25 times higher (37 %) than that found among the same age group in the general population of the EU (GPS 1.5 %) (EMCDDA, 2015a). This varies greatly by country — see Figure 4.

A study by Boys et al. (2001) identified that the most popular reasons for using MDMA were similar to those for amphetamines: to 'keep going' (91 %), to enhance activity (80 %), to feel elated/euphoric (78 %), to stay awake (72 %) and to become intoxicated (68 %). The recreational use pattern is supported by findings from the SCORE wastewater study, with most cities reporting higher loads of MDMA detected during the weekend (Friday to Monday) than during weekdays (EMCDDA, 2015b).

FIGURE 4

Recent MDMA use among young adults from different samples: general population surveys (GPS) and Global Drug Survey (GDS) (clubbers and non-clubbers)



Source: EMCDDA Statistical Bulletin, available at http://www.emcdda.europa.eu/data/stats2015 and 2014 Global Drug Survey (http://www.globaldrugsurvey.com/)

MDMA and electronic dance music

Electronic dance music (EDM) and the settings where this genre is played (clubs, raves or festivals) have historically been associated with MDMA consumption. From the late 1990s to around 2010 this music genre remained mostly confined to a limited number of dedicated electronic dance festivals across Europe and favoured by a sub-population of party-goers. Towards the end of this period club-goers began to lose interest in MDMA tablets, which became known for their low quality, and began to use powder and crystal forms of MDMA, which were considered to have higher potency.

From 2010 onwards the electronic dance music genre moved from the margins to the social and cultural mainstream, mainly due to large entertainment corporations investing in the promotion of EDM acts and establishing dedicated events that attract hundreds of thousands of party-goers. EDM as an industry sector is valued at seven billion dollars yearly (Watson, 2015), and in July 2014 Belgium hosted the largest EDM festival with almost 360 000 people attending over two weekends. This global commercial success of EDM provides a huge and fertile ground for the distribution of MDMA among a new generation of young consumers who were born after the 1990s clubbing and 'ecstasy' events. The historical link between 'ecstasy' and the clubbing movement of the 1990s/2000s has thus been replaced by mainstream EDM and 'MDMA'. Current indications suggest that in higher prevalence countries the use of MDMA is no longer a niche or subcultural drug (i.e. it is not limited to techno clubs and parties); it is now regularly used by a broader group of young people in mainstream nightlife settings, bars, festivals and house parties.

The potential consumer base for MDMA is considerable, and reports from outreach agencies and ethnographers involved in this study suggest that in some countries there is a new young generation of MDMA users who do not recognise the 1990s name of 'ecstasy' but know the drug as either MDMA or one of a number of street names including 'Molly', 'Adam', 'Mandy' or 'Crystal'. Amongst this group of new younger users there is in some cases misunderstanding and restricted knowledge about MDMA's effects, composition and harms. Often, brands or logos are perceived as sufficient indicators of quality and some report that crystal and tablets are thought to be different drugs.

With regard to the impact on drug treatment, MDMA problems are rarely reported as a reason for entering specialised drug treatment services, with the drug being responsible for less than 1 % (around 800 cases) of reported first-time treatment entrants in Europe in 2014.

Just three countries account for over half (56 %) of all first-time entrants for MDMA: the United Kingdom (200 cases), Spain (167 cases) and Turkey (74 cases).

MDMA harms and deaths

MDMA-related harms

Reports of health problems related to the use of MDMA appear to be relatively uncommon, although there are limited systematic data to be able to substantiate this. It is likely that the risks are greater when MDMA use is associated with polysubstance use and with the use of high-purity tablets; there are also increasing reports of acute toxicity associated with the use of tablets adulterated with other substances such as PMMA. Although much more is known about MDMA than other club drugs, the evidence is still limited with regard to its acute and chronic harms. Much of the clinical evidence is derived from case reports, a small number of prospective observational studies, retrospective audits and analysis of patient records (Abdulrahim and Bowden-Jones, 2015).

Nevertheless, MDMA may potentially cause significant acute toxicity, which can manifest as neuropsychiatric effects and sympathomimetic/stimulant effects. Common effects include agitation, nausea, headache, sweating, bruxism, insomnia, blurred vision, increased heart rate and raised blood pressure. Severe acute toxicity may be characterised by hyperthermia and related secondary manifestations; serotonin syndrome; seizures; arrhythmias; and, rarely, hyponatremia (Dargan and Wood, 2013).

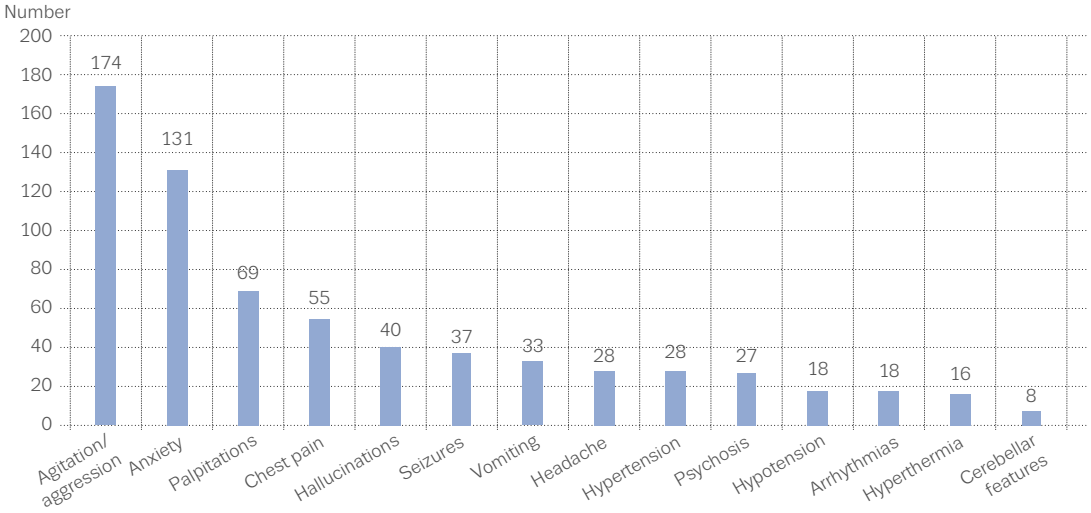
MDMA dependence or tolerance is not common. However, long-term somatic effects may include damage to the central nervous system. Long-term neurological or cognitive harms may include impairment of memory, impairment of higher cognitive brain functions, and damage to dopamine and serotonin nerve terminals; although the data to support these associations are contradictory. Mental health risks associated with MDMA include acute psychosis, confusion, depressed mood ('midweek blues') and, in the long term, impulsivity, depressive symptoms, elevated anxiety and prolonged psychosis (Karlsen et al., 2007; Rogers et al., 2009).

MDMA hospital emergency presentations

As noted above, there are limited systematic data on acute drug toxicity in Europe, and this also applies to MDMA

FIGURE 5

Clinical features related to acute MDMA toxicity (Euro-DEN data, 2014)



Source: Euro-DEN data, 2014.

(Heyerdahl et al., 2014). Information about acute health harms related to MDMA use comes from reports from emergency settings. Since 2013 the Euro-DEN network has been collecting systematic data on drug-related presentations to the emergency departments of 16 sentinel centres in 10 European countries. From October 2013 to December 2014 there were 549 presentations (8.1 % of the total) that involved acute toxicity relating to MDMA use (MDMA was involved in more than 10 % of presentations to five of the 16 Euro-DEN centres). A total of 70.5 % of these presenting were male and the mean age was 24.7 years. The mean ± SD number of drugs used in the presentations involving MDMA was 1.9 ± 0.7 — around half (47.2 %) involved MDMA alone, and just under a third (29 %) involved the use of one additional substance, usually alcohol.

The most common clinical features were agitation/ aggression (31.7 %), anxiety (23.9 %), palpitations (12.6 %) and chest pain (10.0 %) (Figure 5). Around three-quarters of cases were discharged direct from the emergency department, most within 12 hours. Some 5 % required critical care admission. Sixteen patients developed hyperthermia, and significant complications such as rhabdomyolysis were more common in these cases, including the two deaths seen in this cohort. In terms of change over time, there was no significant difference in the proportion of presentations involving MDMA between October–December 2013 (9.1 %) and October–December 2014 (7.2 %).

Reported clinical data from a study in Ibizan emergency services situated close to party settings (2008–14) identified 8 781 drug-related presentations with around half (46 %) involving MDMA. Alcohol and MDMA were the most common drug combination among all presentations.

MDMA-related deaths

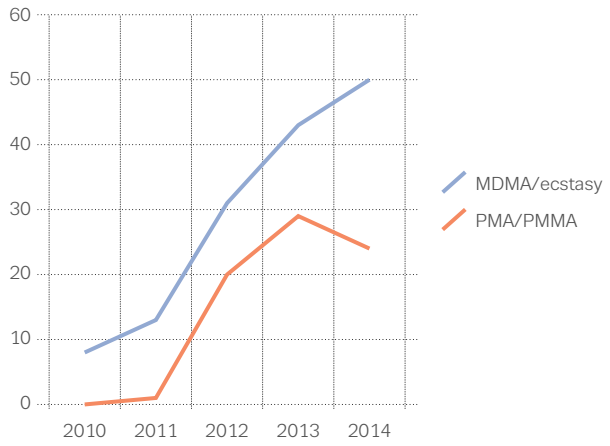
During 2015 case reports of deaths where highly dosed MDMA pills may have been involved received much media attention in Europe, in particular in France, Belgium, the Netherlands and the United Kingdom.

At a European level, however, the number of MDMA-related deaths reported is low, when seen from the perspective of the more than 6 000 drug-related deaths that are reported annually, most of which relate to opioids (EMCDDA, 2015a, 2015c). For example, where data on post-mortem toxicology were available, there were 14 deaths with MDMA reported in Ireland (of 219 cases in total in 2014) and five in France (of a total 264 cases in 2013). Preliminary analysis of the data reported by countries up to October 2015 suggested an increase in some countries — for example in Germany, France and Ireland. However, as the number of fatalities is small in these countries, no significant trend is confirmed so far.

The trend in Turkey is an exception, with 113 deaths where MDMA is mentioned in post-mortem toxicology of overdose cases in 2014, which is twice the number reported in 2013. This increase occurred in the context of a large increase in the overall number of drug-related deaths. It is important that this phenomenon is more thoroughly investigated before conclusions are drawn.

FIGURE 6

Number of MDMA- and PMA/PMMA-related deaths, 2010–14 trend, England and Wales



Source: Office for National Statistics (ONS), 2015.

In England and Wales reports of MDMA-related deaths have also increased, although at lower levels. Similar to the situation in Turkey, this also occurred in the context of an overall increase in other drug-related deaths, but alongside a recent reduction in PMA/PMMA-related deaths (Figure 6).

This distinction between trends in MDMA and PMMA is important, and in many countries a proportion of deaths that were attributed to MDMA were in fact associated with tablets adulterated with other substances, in particular with PMMA.

There is likely to be an underestimation of MDMA-related deaths, as is the case for drug-related deaths in general. There are limitations and variability across Europe in the identification and definition of drug-related deaths, and not all deaths are subject to autopsies and full toxicological screening. Post-mortem toxicology data are not always available, nor consistently used for coding and for the monitoring of drug-related deaths. This could be the case in particular in some of the countries with potential MDMA concerns.

Re-emergence of research on MDMA-assisted therapy for mental disorders

Since 2000 the United States Drug Enforcement Administration and Food and Drug Administration have allowed research trials for studies on MDMA-assisted psychotherapy for (treatment-resistant) post-traumatic stress disorder. Research trials are currently mainly carried out in Canada and the United States and have reached phase II stages with initial positive clinical responses – in this phase the drug is given to a larger group of people to see if it is effective and to further evaluate its safety. Phase III studies are scheduled for 2017.

Discussion

MDMA market recovery and consolidation

Europe has experienced a recent resurgence in the use of MDMA, with much stronger tablets and powders now commonly available in several Member States. It appears that the resurgence of the drug began in 2010/2011, associated with the development of an alternative, synthetic pre-precursor that proved to be more reliably available than safrole or PMK. This underlines the importance of pre-precursors and understanding chemical processes, as they shape the market to some extent. It is possible that 2014 represented a peak year for high-purity pills (in countries such as the Netherlands and the United Kingdom), and there are reports that use of MDMA is becoming normalised in certain youth populations. This raises questions as to whether use of the drug has reached saturation point in some countries or whether there is the potential for it to spread further.

However, the picture is not uniform across Europe. While overall it appears that Europe's MDMA market is now in a period of consolidation, there may be some temporal ripple effects as late-comer countries catch up. Higher dose MDMA tablets currently appear to be available in many EU countries, although patterns of use are influenced by local stimulant markets; for example, patterns of MDMA use in the Czech Republic are influenced by methamphetamine trends, and the Spanish situation is interlinked with cocaine use.

There also appears to be some limited interplay between MDMA and local NPS markets. One example is the potential interplay between cathinones such as mephedrone and MDMA, although the available evidence appears to suggest that NPS are generally added to other drugs rather than replacing them, particularly in established users (Moore et al., 2013). Also, MDMA and ecstasy tablets have been associated with both substitution and by-products (PMMA). Nonetheless, the situation where NPS rather than MDMA were the normal active ingredient in ecstasy tablets has largely been

reversed since 2011, with MDMA re-occupying a central place in the drug market as a distinct commodity in itself.

Decentralised, more sophisticated and innovative models for production and supply

Market indicators suggest a complex MDMA market structure in which suppliers are innovating to encourage growth and adopting marketing strategies to gain a larger share of a growing market. The Netherlands and Belgium remain the global centre of MDMA production, but it is not clear that they will remain so indefinitely. OCGs in these countries appear to have maintained a competitive advantage so far with the specialisation of production and decentralisation of specific roles (expertise, logistics, specialisms, chemical recovery). Innovation and increased variation is evident in production processes (in terms of the precursors used, essential chemicals routes, equipment, production to order, internet sale and the use of postal services) and a growing range of products (MDMA oil, crystals, designer pills, logos, etc.). There is also innovation and decentralisation at the geographical level, potentially adding tiers of security and making the market more resilient to intervention. This includes both mobile production and dispersal of different stages of production. In addition, there is evidence of the use of third countries for importing precursors, and the emergence of new global markets (Turkey, Brazil, Australia, etc.) where EU countries are clearly exporters.

In particular, the sale of MDMA via darknet markets on the deep web could potentially be a game changer, with new players entering the marketplace and the declining importance of established organisational structures, including OCGs.

Consumer dynamics

This study also raises the question of the role played by supply factors in shaping demand and driving new MDMA consumption behaviours. There are delays in the provision of available indicator data on patterns of MDMA use, in particular with general population surveys. Internet surveys are promising but have sampling weaknesses. Nevertheless, all the signs suggest an upturn in the use of MDMA in many European countries between 2011 and 2015.

Overall patterns of drug use are now probably more dynamic and complex than in the first iteration of MDMA use in the 1990s. A generational shift is evident among MDMA consumers, reflected in consumption patterns and differentiated product types and names. In some countries use is increasingly normative, with MDMA functioning as a consumer product within the recreational economy and less linked to specific subcultures and settings than in the past. This in turn raises new concerns around normalising higher dose MDMA products. In addition, the use of the internet, both for supply purposes and for consumer communication around product availability and quality, is becoming increasingly influential. Online forums are a nexus for discussions on product choice, which in turn is influenced by branding and product form.

This new generation of MDMA users may challenge our existing approaches to working with consumers and require a rethink of our traditional nightlife interventions.

Harms: implications and questions

Although there are limited data on the prevalence of drug-related acute toxicity in Europe, overall the current level of serious acute harms associated with the use of MDMA appears to be low. However, there is concern related to high-dose MDMA tablets, adulteration with highly toxic substances such as PMMA and younger and uninformed users. At present, the reporting of hospital emergency presentations and drug-related deaths remains fairly rudimentary in many countries. There is also continued uncertainly around the harms related to chronic MDMA use, particularly the consumption of high doses over time. Interactions with other drug consumption patterns (especially sedatives, alcohol, tobacco and replacement stimulants) may become more important over time. Nevertheless, there is the potential for increases in MDMA-related problems — there are a number of clear risk factors:

- With increased rates of prevalence, the population at risk increases.
- With more novice users, the likelihood of problems linked to inexperience in drug taking increases.
- With increased doses of MDMA in available products, the relative risk of all users experiencing problems increases.

The evident market instability in respect to potency is probably one of the greatest threats, with high variability of MDMA content in similar looking products. Although the increased market supply of MDMA potentially reduces the rationale for and likelihood of adulteration, the increased use of this drug at festivals and mainstream events continues to provide an opportunistic market for exploitation with 'adulterants'.

The primary arena for harm reduction responses has been linked with product adulteration and higher dose MDMA products. Pill checking, issuing of warnings and alerts, and consumer information and advice have been implemented. This emerges as an area with an identified need for the development of new evidence for effectiveness and behavioural change. As the subcultural importance of MDMA has reduced — with use less tied into electronic dance music — the traditional harm reduction methods appear to be increasingly out of date, and an important finding of this study has been the need for services to engage and work with a new, younger generation of more mainstream users.

There is clearly a central role for the Internet in expanding consumer reach and targeting differential consumer risk behaviours. This is likely to require the development of a consensus on and processes for effective messaging, and also the development of new intervention models across the areas of rapid response, harm reduction and prevention.

Acknowledgements

The EMCDDA would like to acknowledge the expert contributions made to this publication by: Peter Blankaert, Tibor Brunt, Alexander Bücheli, Paul Dargan, Liv Flesland, Andres Garcia, Klaidas Kuchalskis, Sébastian Lose, Cathelijne Lyphout, Lucie Maskova, Alexander van Nuijs, Bulent Sam, Helena Valente, Joost van Besselaar, Bernard van Camp, Jorrit van den Berg, Claudio Vidal.

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TD-01-16-348-EN-N

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doi:10.2810/817237

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